Practise

For help with questions 1 and 2, see the Example.

1. The table shows the path of a ball, where x is the horizontal distance, in metres, and h is the height, in metres, above the ground.

x	h
0	1
1	8
2	13
3	16
4	17
5	16
6	13
7	8
8	1

a) Sketch a graph of the quadratic relation.

b) Describe the flight path of the ball. Identify the axis of symmetry and the vertex.

c) What is the maximum height that the ball reached?

d) Verify that $h = -x^2 + 8x + 1$ can be used to model the flight path of the ball.

2. The underside of a bridge is an arch that can be approximated by the relation $y = -0.1x^2 + 10$, where y is the height, in metres, above the ground and x is the width, in metres, from the centre of the bridge.

a) Graph the quadratic relation.

b) Describe the shape of the arch.

c) How tall and wide is the arch?

3. Use finite differences to determine whether each relation is linear, quadratic, or neither.

a)

x	y
0	4
1	5
2	6
3	7
4	8

b)

x	y
0	3
1	4
2	7
3	12
4	19

c)

x	y
1	0
3	1
5	8
7	27
9	64

d)

x	y
-2	6
1	0
4	12
7	42
10	90

Connect and Apply

4. This section has photographs of parabolic arches in architecture, furniture, bridge design, and nature. Find five more examples of parabolic arches. Some possible sources are the Internet, personal surroundings, or print-based material. Explain how you determined that your examples are parabolic.

5. The parabolic shape of the Humber River Pedestrian Bridge in Toronto can be approximated by the equation $h = -\frac{1}{144}x^2 + \frac{5}{6}x$, where x is the horizontal distance, in metres, from one end and h is the height, in metres, above the water.

a) Graph the quadratic relation with or without technology.

b) What is the height of the bridge 12 m horizontally from one end?

c) How wide is the bridge at its base?

d) What is the maximum height of the bridge? At what horizontal distance does it reach that height?

e) Identify the axis of symmetry of the bridge.

6. **Use Technology** A ball is thrown upward at an initial velocity of 15 m/s, from a height of 1.5 m. The height, h, in metres, of the ball above the ground after t seconds can be found using the relation $h = -4.9t^2 + 15t + 1.5$.

   a) Graph this relation using a graphing calculator.

   b) Describe the relationship between time and height.

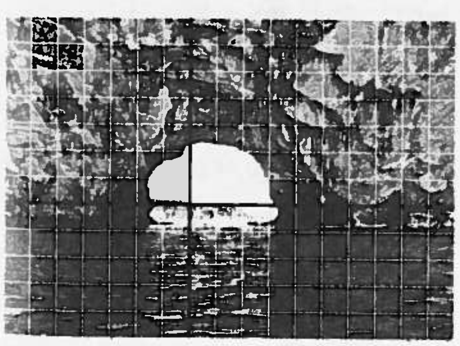
   c) Repeat parts a) and b) for a ball thrown upward on the Moon, with height defined by the relation $h = -0.81t^2 + 15t + 1.5$.

   d) Repeat parts a) and b) for a ball thrown upward on Jupiter, with height defined by the relation $h = -11.55t^2 + 15t + 1.5$.

   e) Compare the results from the three locations.

7. **Chapter Problem** A city opened a new landfill site in 2000. In Section 4.1, question 6, you created a table of values showing the total mass of garbage in the landfill for each year from 2000 to 2007. Use your table and finite differences to determine if the relationship more closely models a linear or a quadratic relation. Justify your decision.

8. Percé Rock is located at the eastern tip of Quebec's Gaspé Peninsula. Make a table of values of at least seven points, so that the x-values are equally spaced. Use finite differences to determine how close the arch is to a parabola.



Achievement Check

9. The path of a rocket fired at a Canada Day fireworks display is given by $h = -4.9t^2 + 19.6t + 0.4$, where h is the height, in metres, of the rocket above the ground and t is the time, in seconds.

   a) Make a table of values for $t = 0$ to $t = 4$.

   b) Make a table of first and second differences. What conclusion can you make?

   c) Draw a graph of the path of the rocket using the table of values from part a) or graphing technology. Describe the path of the rocket.

   d) How high above the ground was the rocket when it was set off? Explain your answer.

Extend

10. The flow rate of water through a garden hose depends on the water pressure and the diameter of the hose opening. At a normal water pressure of 345 kPa, the flow rate can be calculated using the formula $r = 2d^2$, where d is the diameter, in centimetres, of the hose opening and r is the flow rate, in litres per second. How long would it take to fill a 200-L barrel using a hose with a 0.3-cm-diameter opening?

11. The sum of the first n natural numbers is a quadratic relation. Determine that relation and verify it for the first six natural numbers.